

Jun 26th, 1:50 PM - 2:10 PM

Concurrent Sessions A: Emerging Engineering Solutions for Downstream Fish Passage at Big Dams - Survival Improvements at Fish Guidance Systems Designed to improve Safe Downstream Passage of Anadromous and Catadromous Fish

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A Positive Barrier Guidance System Designed to Improve Safe Downstream Passage of Anadromous Fish

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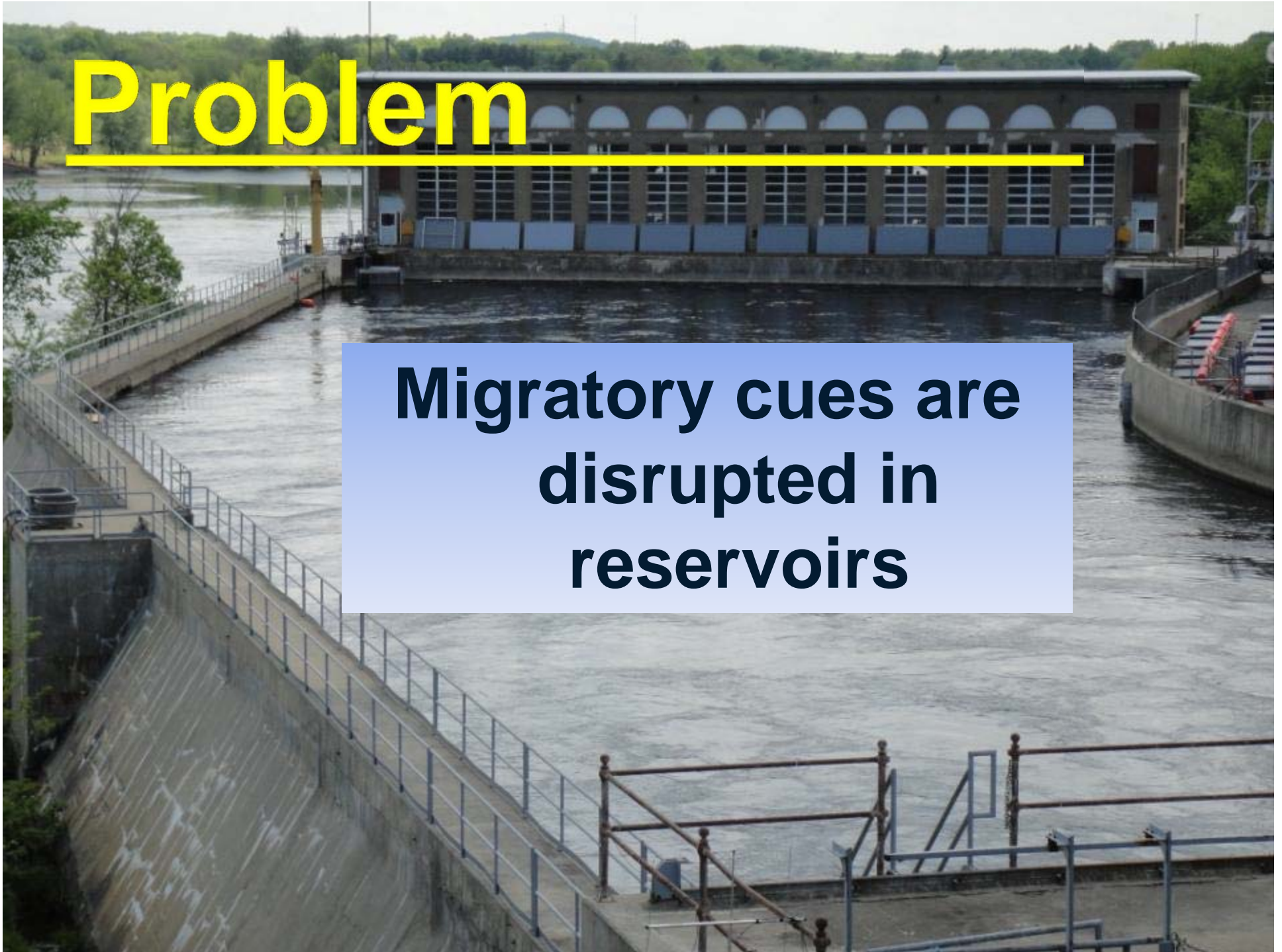
Juvenile Fish Passage Behavior

In general, juvenile anadromous salmonids and clupeids (river herring and shad):

- **Follow bulk flow in the river thalweg**
- **Are surface oriented**
- **Cue on flow and turbulence**
- **May respond to changes in water quality**

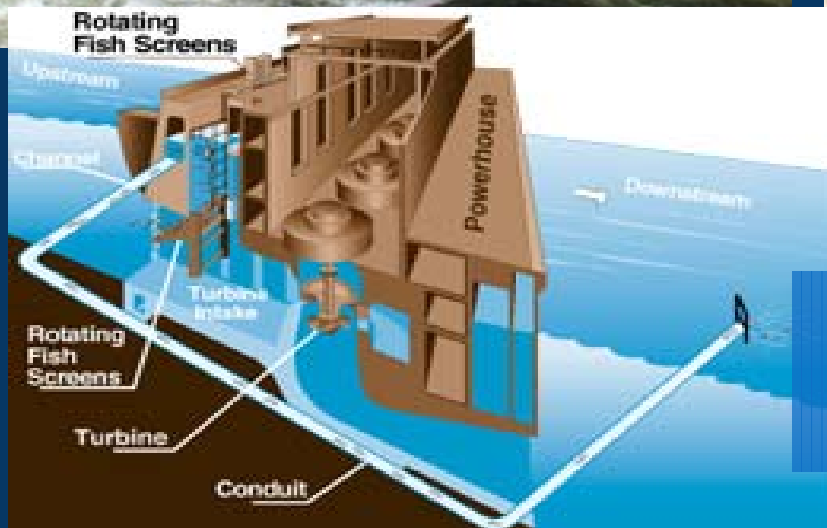
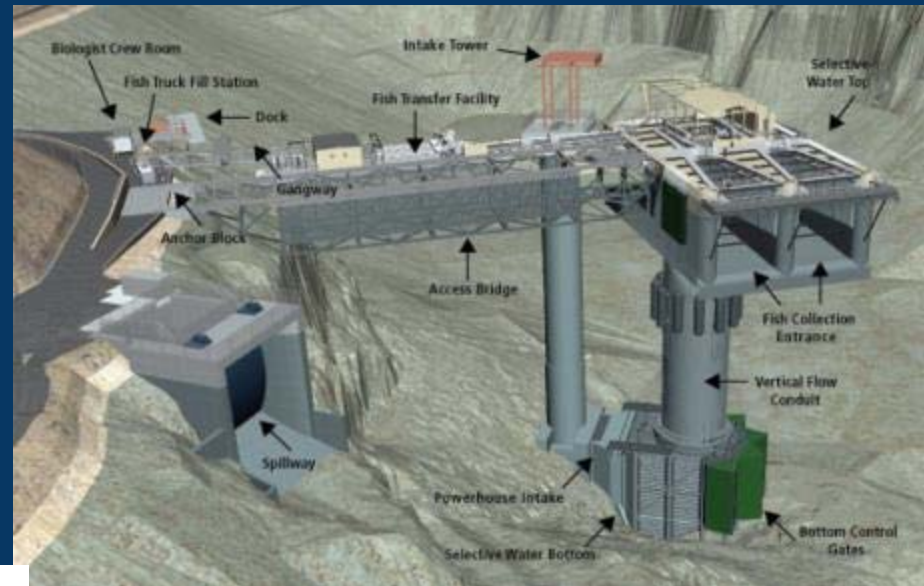
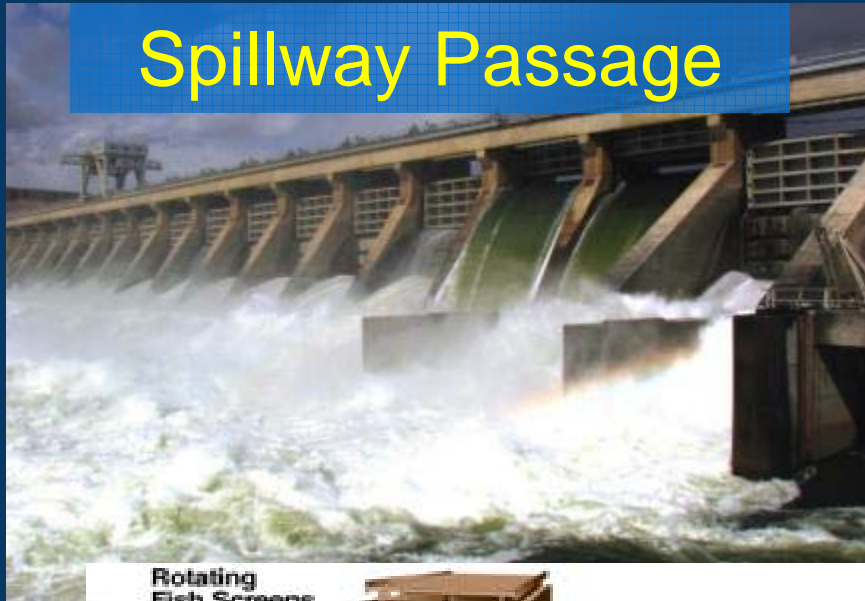
Problem

**Migratory cues are
disrupted in
reservoirs**



Juvenile Fish Bypass

Spillway Passage



Collection and Transport Systems

Screened Turbine Intake and Bypass

Non-Physical Guidance

Lights



Acoustic



Bubble Curtains



Fish Guidance System



Fish Guidance System

- Provides several cues to alter fish migration routes
 - Physical
 - Visual
 - Hydraulic

Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Image U.S. Geological Survey

©2010 Google

Imagery Date: 4/1/2006 1996

46°14'59.90" N 118°52'23.84" W elev 444 ft

Eye alt 6029 ft

Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Bulk Flow ←

Image U.S. Geological Survey

©2010 Google

Imagery Date: 4/1/2006 1996

46°14'59.90" N 118°52'23.84" W elev 444 ft

Eye alt 6029 ft

Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Intermediate
Zone

Bulk
Flow

Image U.S. Geological Survey

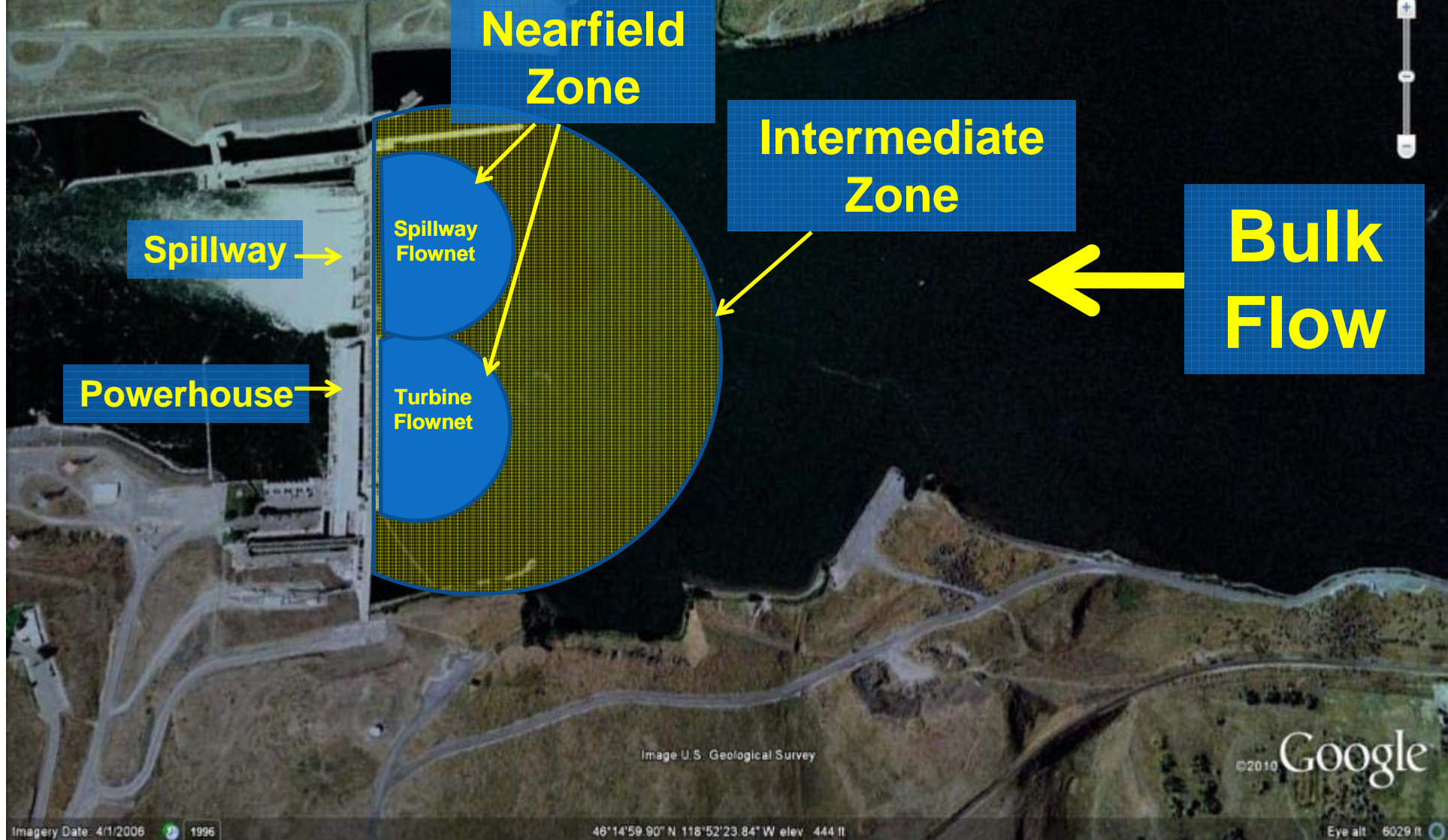
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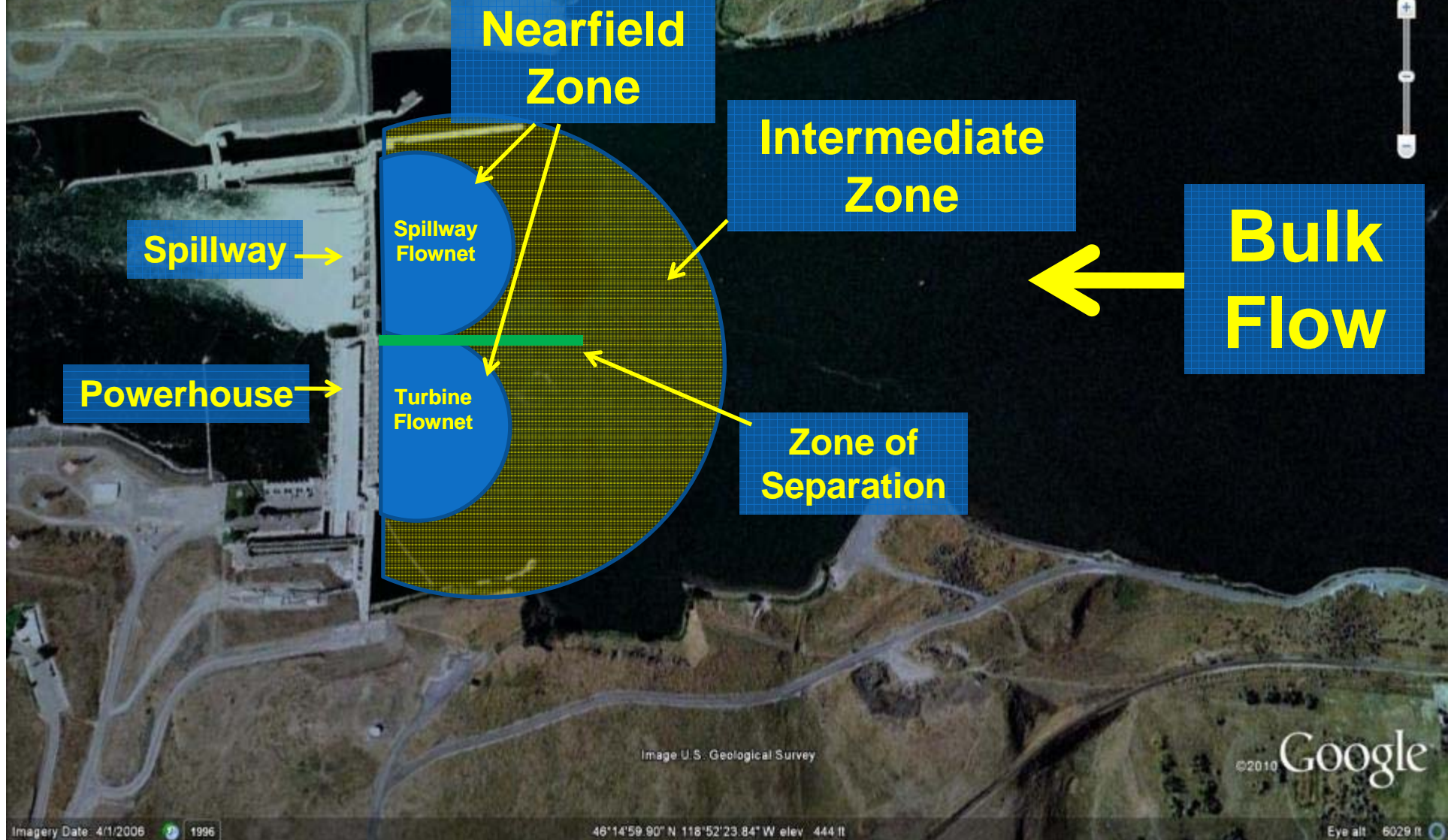
46°14'59.90" N 118°52'23.84" W elev 444 ft

Eye alt 6029 ft

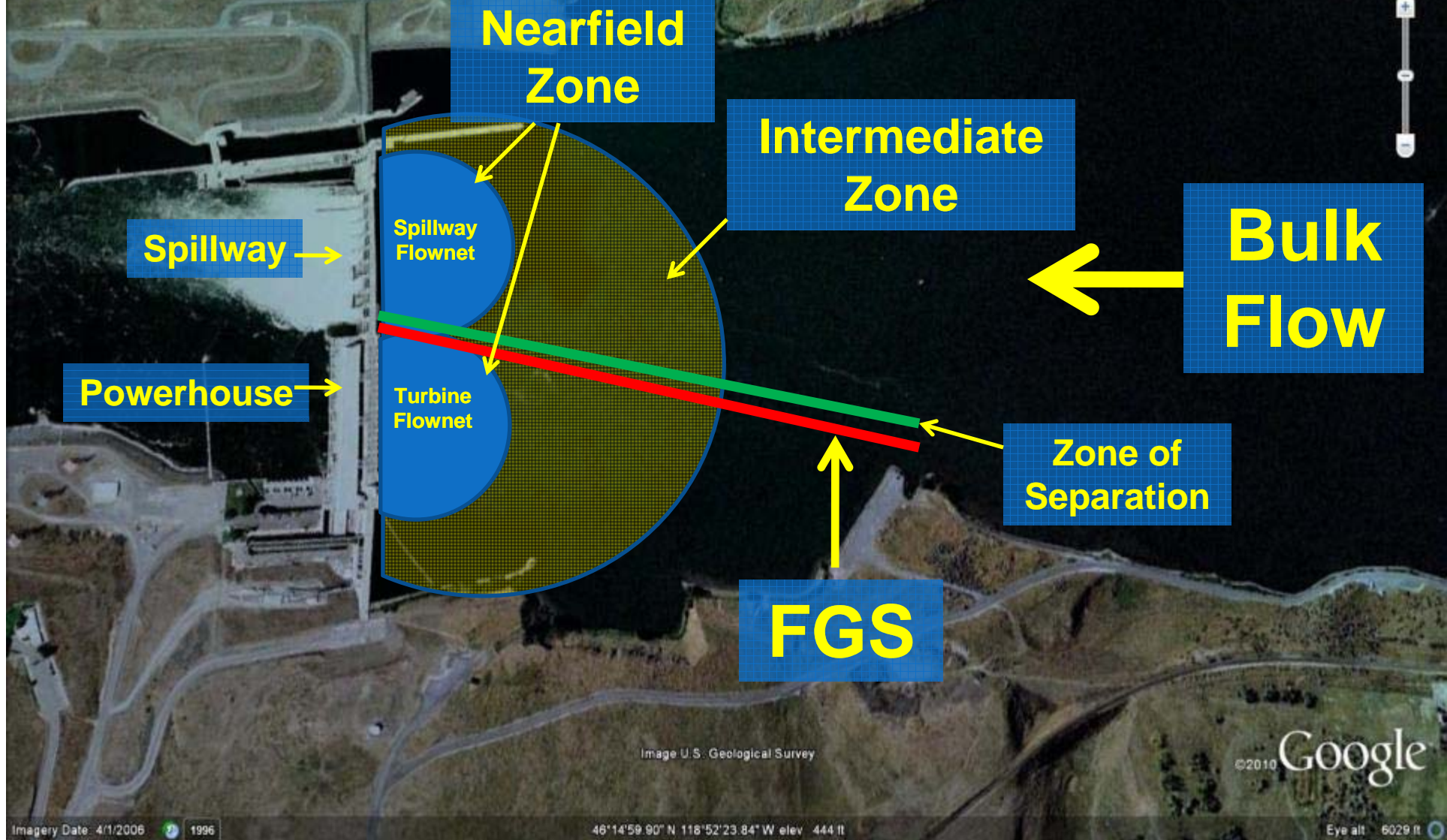
Forebay Hydraulics and Fish Behavior



Forebay Hydraulics and Fish Behavior



Forebay Hydraulics and Fish Behavior



Lower Granite Dam

Snake River, Washington State

Prototype
Surface Bypass
System

Debris Boom

FGS

Image U.S. Geological Survey

©2010 Google

Imagery Date: 4/1/2006 1996

46°39'29.88" N 117°25'31.63" W elev: 742 ft

Eye alt: 5465 ft

FGS Results

- 80% Guidance
- Reduced turbine entrainment 16%

FGS

Bonneville Dam, Columbia River, WA

PH 2

Spillway

PH 1



US Army Corps
of Engineers®

Image U.S. Geological Survey
Image © 2011 TerraMetrics
Image © 2011 GeoEye

©2010 Google

Imagery Date: Aug 2, 2010

45°38'32.13" N 121°56'27.49" W elev. 95 ft

Eye alt. 14331 ft

Bonneville Dam, Powerhouse 2 Fish Guidance System

Powerhouse



US Army Corps
of Engineers

Juvenile
Bypass
Channel

Fish
Guidance
System



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© 2011 Europa Technologies
Image © 2011 GeoEye

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Imagery Date: Aug 2, 2010

45°38'50.53"N 121°56'07.19"W elev 77 ft

Eye alt 1360 ft

FGS Results



US Army Corps
of Engineers

- 15% guidance improvement for juvenile spring chinook passage
- Guided fish entered the bypass at 2x the rate of unguided fish

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Image © 2011 GeoEye

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Cowlitz Falls Dam, Cowlitz River, WA



Surface
Collector

FGS



Image © 2011 GeoEye

Imagery Date: Aug 27, 2009

48°28'00.13" N 122°06'20.66" W elev. 799 ft

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Eye alt. 4390 ft

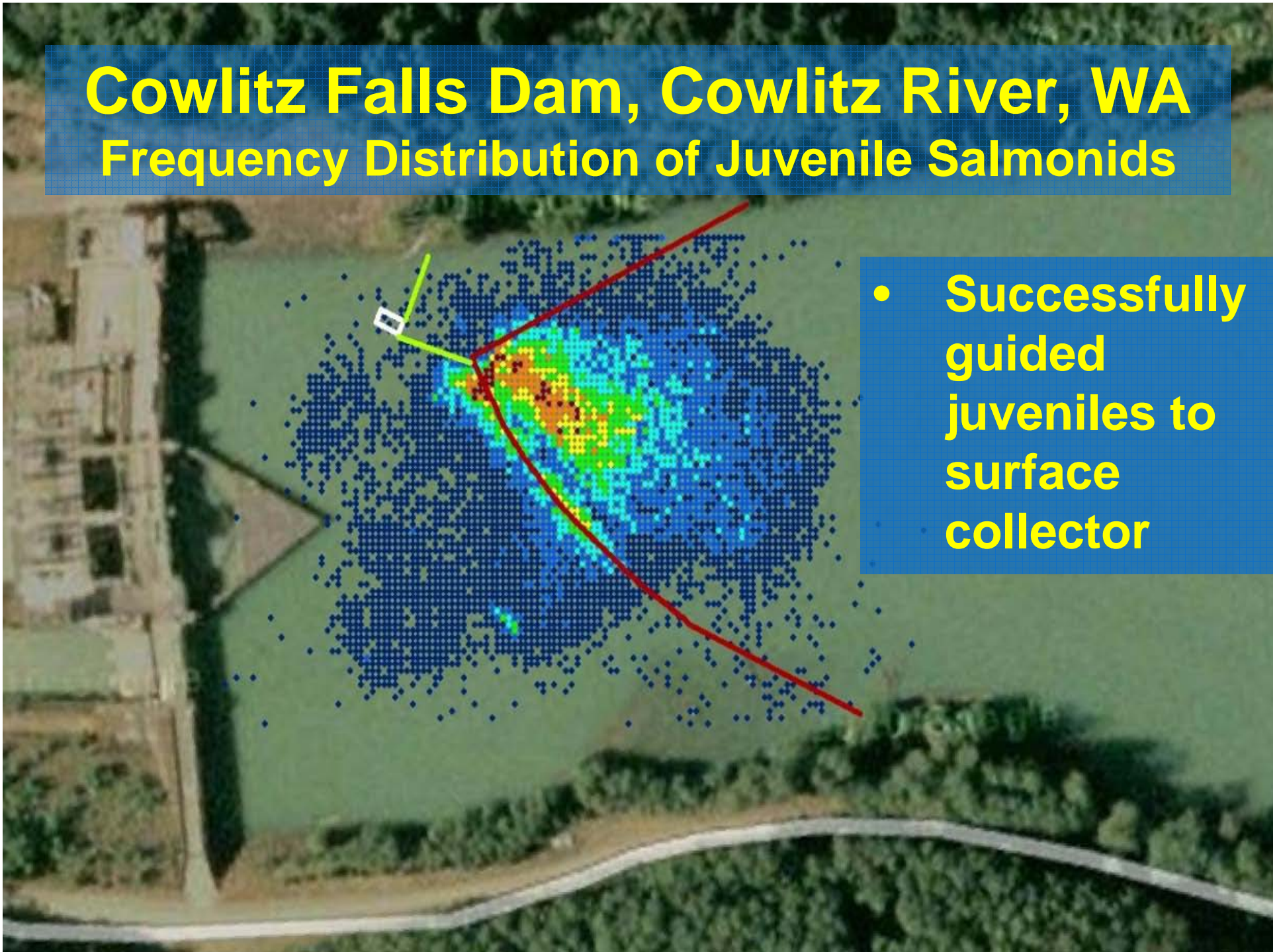
Cowlitz Falls Dam, Cowlitz River, WA



Cowlitz Falls Dam, Cowlitz River, WA

Frequency Distribution of Juvenile Salmonids

- Successfully guided juveniles to surface collector



Lockwood Station, Kennebec River, ME



FGS

Powerhouse



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Image USDA Farm Service Agency

Google earth

Imagery Date: 9/11/2011 1997

44°32'47.88" N 69°37'40.13" W Elev: 36 ft

Eye alt: 2315 ft

Lockwood Station, Kennebec River, ME



Weston Station, Kennebec River, ME

Weston Dam, Skowhegan, ME 04976
Skowhegan



Sluiceway

FGS

Image © 2011 Maine GeoLibrary

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Imagery Date: Jan 1, 2003

44°45'48.83" N 69°43'06.00" W elev 154 ft

Eye alt 2506 ft

Weston Station, Kennebec River, ME



Bypass



Kennebec Dam, Kennebec River, ME

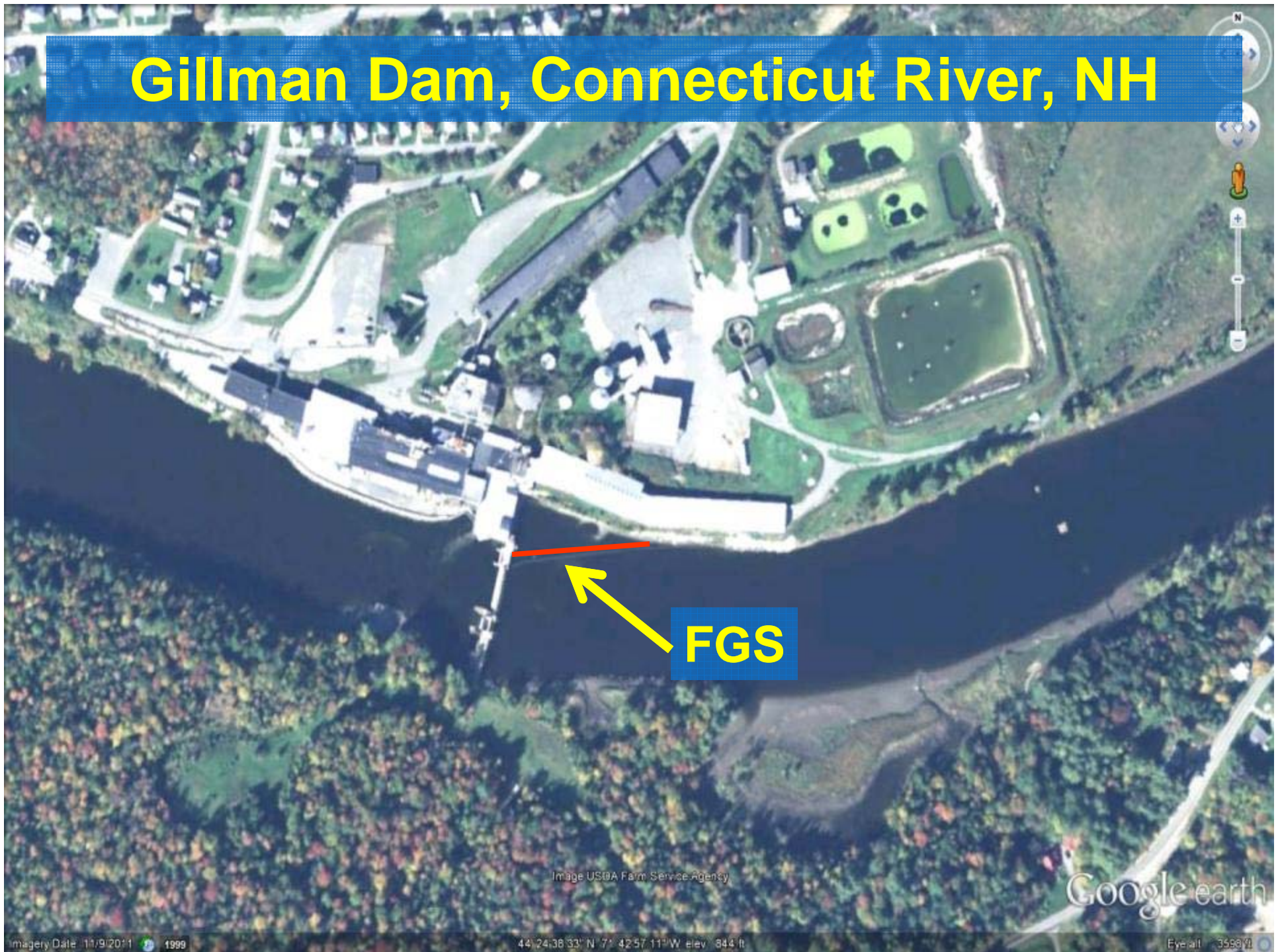


Kennebec Dam, Kennebec River, ME

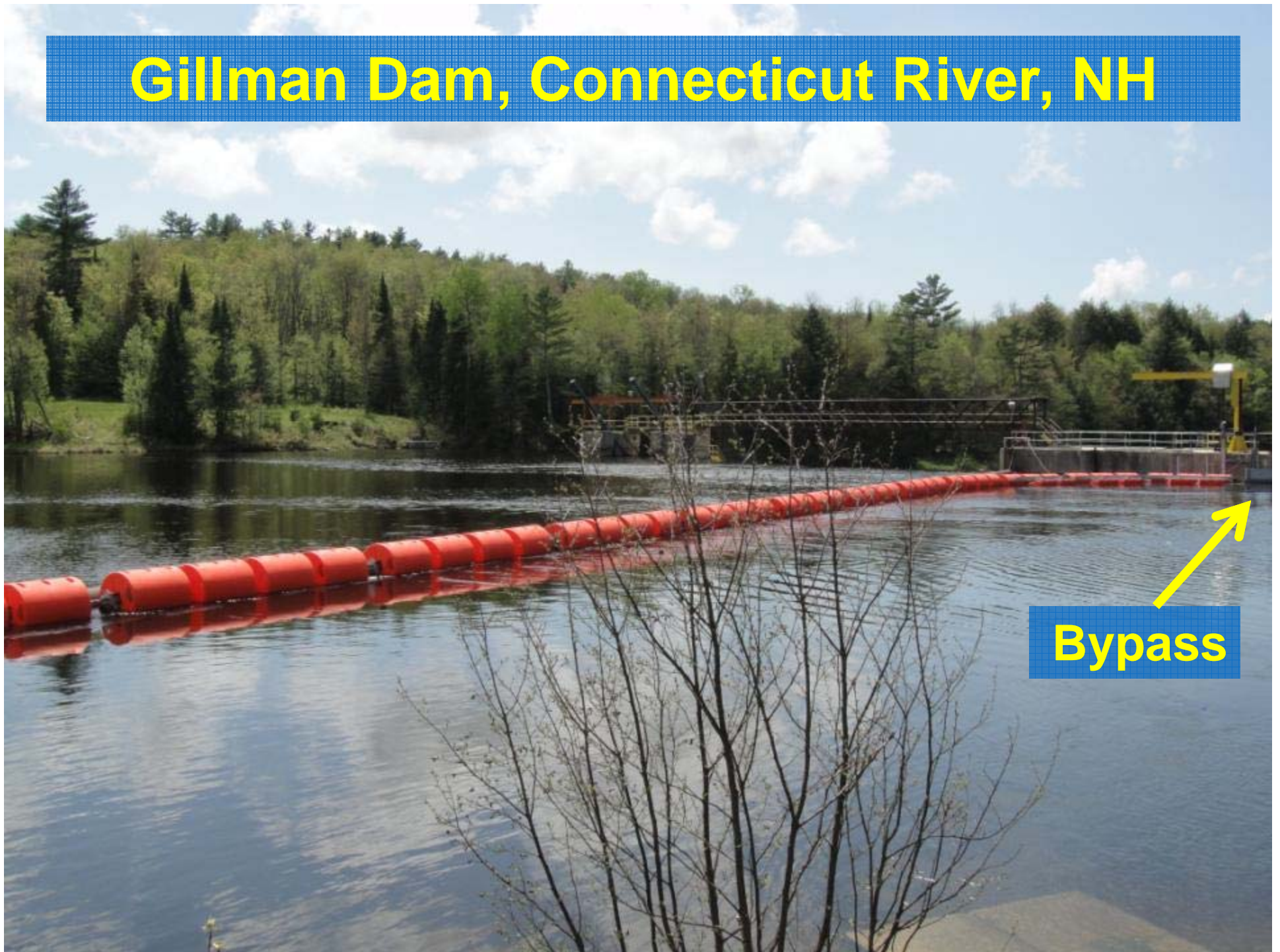
Bypass



Gillman Dam, Connecticut River, NH



Gillman Dam, Connecticut River, NH



Bypass

Summary

- **Permanent Physical Structure**
- **Significantly Improves Juvenile Fish Guidance and Survival**
- **Flexible Configuration to Allow Improvements**
- **Can Reduce Operations Costs**

Recommendations

- **Know Site Specific Conditions**
- **Provide Adequate Bypass**
- **Address Debris**
- **Work With Manufacturer**
- **Be Flexible – Modifications Will Further Improve FGS Performance**

Thank You

Brookfield



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of Engineers®**

Fish Guidance System



QUESTIONS?

